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Evaluation of Health Indicators and the Quality of Used Frying Oils in Fast Food Restaurants of Mashhad in 2018

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ABSTRACT

Introduction: Recently, changes in people's lifestyles and new eating habits have diminished the importance of main dishes and have led to increasing the consumption of fast foods. Therefore, paying close attention to the health conditions and safety of the food provided in these centers can dramatically reduce the incidence of various diseases. The present study examines the environmental health status and the quality of used frying oils (the most important health assessment indicators of fast food restaurants) in the fast food shops and restaurants of the metropolis of Mashhad in the areas adjacent to the holy shrine which has the highest number of pilgrims and tourists.

Materials and Methods: A total number of 120 of fast food shops were selected by *quota* sampling method and were sampled during peak working times. The environmental health status of these centers was evaluated based on food, drink, cosmetics, and health material regulation. Demographic data of personnel, area and antiquity, type, duration and frequency of using oil, the temperature, TPM, and FFA were also measured.

Results: According to the results; 32.5% of the subjects were in hygienic status, and 67.5% of the subjects were in sanitary status. Palm oil was the most widely used oil type. TPM and FFA indices were in the unfavorable condition in 49 samples (40.8%) and 75 samples (62.5%), respectively. There was a significant relationship between temperature, the period of using oil and TPM, and FFA indices.

Conclusion: According to the high volume of customers, quality and health assurance of food is of utmost importance. Therefore, the importance of renovating the buildings, training the operators and staff, continuous monitoring, and applying severe legal measures can be the most important corrective actions.

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Introduction

Recently, changes in people's lifestyles and new eating habits have diminished the importance of main dishes and have led to increasing the consumption of fast foods[1]. Fast foods include all types of sandwiches, hamburgers, cheeseburgers, fried chicken, fish and shrimp, hot dogs, fried potatoes, chicken nuggets, pizzas, and sausages[2].

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The consumption of these foods due to their good taste, high energy, fast preparation, and low prices has dramatically increased in all countries and especially among youth and teenagers[3-5]. According to the latest surveys done by the central bank of the Islamic Republic of Iran, by the end of 2015, each Iranian household spent 711,000 Tomans (equal to 2% of total household expenditure) to buy fast food, annually. However, only less than 5% of fast food restaurants surveyed in Iran have the necessary hygiene quality in different areas namely personal, food, tool and equipment, and building hygiene [6, 7]. Failure to comply with these health tips can lead to various diseases among consumers[8]. These diseases, which occur through eating unhealthy foods, are caused by a variety of viruses, bacteria, parasites, chemicals, and allergens that impose a serious threat to the public health and impose high health care costs on consumers[9]. Accordingly, greater supervision and control over the implementation of health regulations have been recently introduced by environmental health experts and other medical groups as the main programs of the Ministry of Health and Medical Education so that strong laws and regulations can reduce the harmful effects of environmental pollution to the lowest possible level [10, 11]. One of the most important measures for this purpose is food, drink, cosmetics and health materials regulation which is used to determine the methods for controlling of and dealing with the offenders in the so-called centers for the preparation, distribution, maintenance, sale, and transportation of food, beverages, and cosmetics, and in the public places which are currently running in the country [10].

Another factor that strongly influences the quality of food prepared in fast food centers is the quality of frying oil used. Deep frying is one of the most common food preparation methods especially in fast foods which creates a pleasant taste, texture, and good appearance for the food[12, 13]. Improving the sensory quality of food caused by the formation of aromatic compounds, attractive color, shell, and texture have also caused a large number of harmful reactions[14, 15]. At the frying temperature (which sometimes reaches up to 200°C); the oxidized fats, trans-fatty acids, hydrolyzed fats, sterol derivatives, polymers, polar compounds, acrylamide, and heterocyclic compounds are formed[16]. The non-volatile insoluble material produced also increases the viscosity of the oil and darkens its color and reduces the smoke point[15]. There is no specific criterion for determining the useful life of oils[17]; therefore, continuous monitoring of the quality of fat and oil during food preparation and processing is very necessary and important[12]. According to the National Iranian Standards Organization Standard No. 4152, measurement of Total Polar Materials (TPM) and Free Fatty Acids (FFA) are the most important indicators to evaluate the usability or non-usability of frying oil[18]. Most of the non-volatile by-products are known as TPMs[19]. TPMs are the best indicators for checking the quality and evaluation of frying oils[20]. They consist of dimeric fatty acids, polymerized triglycerides (PTG), aldehydic triglycerides, triglyceride mono hydroperoxides, and cyclic fatty acid monomers[21]. The percentage of TPM in cooking oils is approximately equal to that in food-absorbing oils[22]. FFA is also an indicator of the acidity and hydrolysis of oil. In other words, the formation of FFA and glycerol residues is the result of the oil hydrolysis reaction[23]. FFA is one of the major causes of flavor deterioration and shelf life decrease of oil and is used as an indicator for monitoring the efficiency of oil deodorizers which has a critical role in edible oil and quality control analyses[24, 25].

Regarding the environmental health status of food centers, only four internal studies (3 in restaurants and only 1 in a fast food restaurant) have been done. The study was conducted in 24 restaurants of Zahedan which showed that all of the workers of restaurants and dining halls had the personal health card, and they have passed public health courses. 80 percent of the restaurants were in poor condition. There was no problem in the kitchen and restaurant appearance in terms of hygiene, and most of the health parameters have been taken into consideration[26]. The results for a similar study in Qaemshahr restaurants revealed that only 50 percent of restaurant staff had a health certificate and a medical examination card[27]. Only 1 study has been

conducted regarding the environmental health status of fast food distribution centers in Yasuj; in this study conducted on 20 fast food distribution centers, more than 50% of staff did not wear hygiene uniform; 31.6% had no health cards, and 84.2% of them received money from customers directly. None of the workers used gloves, only 1 of them used the chef hat and 31.6% of personnel did not know how to wash the vegetables[28].

In evaluating the quality of the oil used, the most attention was paid to measuring the peroxide value. In the study conducted in Ilam; the peroxide value of 195 sandwich and Falafel samples was measured and the peroxide value of the used oils was seen to be higher than the standard level. This value was also higher than the acceptable limit for 58 fried food samples in Lahijan sandwich stores and restaurants, and 80% of the samples had peroxide values above 8[29].

Investigation of previous studies has shown that there is a lack of study in the context of evaluating the health indices and quality of used oils (TPM and FFA indices) which can be very important and necessary considering the popularity of these foods especially among adolescents. In addition, investigating the relationship between environmental health status and these indicators can also help in the proper planning for future control and more educational methods.

The present study was conducted to evaluate the health indicators namely TPM and FFA in the fast food shops and restaurants of Mashhad in the areas adjacent to the holy shrine which has the highest visit of pilgrims and tourists.

Materials and Methods

An analytical study was conducted to evaluate the environmental health status and the quality of used oils (TPM and FFA) in Mashhad fast food shops and restaurants.

Study area

The present study was conducted in Mashhad which is known as the second largest religious metropolis in the world and the second largest metropolis of Iran. The best attraction of Mashhad is the shrine of Imam Reza which is the main reason for travelling of millions of pilgrims and travelers from different cities of Iran and from other countries around the world. The holy shrine is located in the central part of the Mashhad, so this has led to introducing this area as one of the main and one of the most important parts of the city[30-32]. This has led to a high concentration of resorts, hotels, motels and a high density of restaurants and fast food shops in the area. Accordingly, the present study was carried out in the fast food shops and restaurants covered by Mashhad Health Centers No. 5 and Samen which are located around the holy shrine. The geographical location of Mashhad and the under study area are shown in Figure 1.

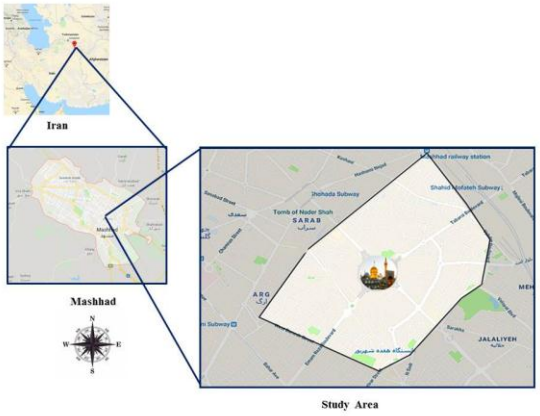

Figure 1: The location of Mashhad and the under study area

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Identifying fast food shops and restaurants

To investigate fast food shops and restaurants, the list of fast food shops was provided from the health centers of the mentioned area and a total of 120 fast food preparation and distribution centers were selected by the quota sampling method. This method provided non-probability samples that are controlled to be distributed like a random sample from a population[33]. It is known as a useful method when probability sampling techniques are not possible when they are cost-effective, and easy by quick usability[34]. The sample size was calculated according to Sajjadi et al. study[35]. Visits and sampling were conducted during the winter season from Wednesday to Friday at the peak of working times of the shops (18-23). General information about the fast food shops and restaurants was selected and the type of fast food restaurant was offered by these shops are shown in Table 1.

Table 1: The type of fast food provided by the fast food shops and restaurants in the study area

Type of fast food provided	Frequency, No. (%)
Hot dog	32(26.7)
Fried potatoes	26(21.7)
Falafel	21(17.5)
Cocktail	21(17.5)
Hamburgers	8(6.7)
Others	12(9.9)
Total	120(100)

Evaluation of environmental health indicators of fast food shops and restaurants

In order to evaluate the environmental health status of these centers; the checklist of food, drink, cosmetics and health materials regulation was used and the health status of the studied shops was evaluated in terms of four aspects including individual health, food, tools and equipment, and buildings. The number of 100 was considered as the total score for each index, and the health status was divided as follows: undesirable level (score ≤ 50), average level (51-70), and desirable level (> 70). Demographic information including age, sex, education, work experience and environmental factors of the shops including year of establishment, health and sanitation status, and area were collected using checklists.

TPM and FFA measurement

Oil sampling was performed according to the national standard of 493 which is approved by the National Institute of Standards and Industrial Research[36]. For measuring the temperature, polarity and free fatty acid content of the oil samples, a portable cooking oil tester (DOM-24 model manufactured by ATAGO, Japan) was used. According to the guidelines of the Iranian National Standards Organization, the maximum permissible limit for the TPM index is 25, whereas the maximum permissible limit for FFA is 1 [37, 38]. Measurements were performed 3 times and the results were reported as the mean score.

Statistical analysis

SPSS and Excel software were used for data analysis and presentation. The significance level was set at 0.05. Accordingly, the Kolmogorov-Smirnov test was used to check the normality of the data, and the Mann-Whitney test and Kruskal-Wallis test were applied to compare the quantitative variable with abnormal distribution in two groups and more than two groups, respectively. Edraw Max software was also used for drawing the various diagrams.

Ethical issues

This study was approved by the Medical Ethics Committee of Mashhad University of Medical Sciences No: IR.MUMS.REC. 1397.214

Results

Demographic characteristics of personnel

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As mentioned above, the demographic characteristics of the personnel were checked using a checklist, and the results were shown in Table 2. All of the staff working in these shops was male, and 80% of the study population had a diploma degree or lower. 56.7% of the personnel had the work experience of fewer than 5 years. Furthermore, 74.2% of the personnel had a health card, and 48.3% had a health certificate.

Table 2: Describing the demographic characteristics of the personnel in fast food centers

Variable, Type	Frequency, No. (%)
Gender	
Male	120(100)
Female	0(0)
Age(year)	
< 25	4(3.3)
26- 45	92(76.7)
> 45	24(20)
Level of education	
Under diploma	38(31.7)
Diploma	58(48.3)
Associate	12(10)
Bachelor	12(10)
Work experience(year)	
< 2	39(32.5)
2- 5	29(24.2)
6- 10	23(19.2)
11- 15	9(7.5)
> 15	20(16.7)
Having health certificate	
Yes	58(48.3)
No	62(51.7)
Health card	
Yes	89(74.2)
No	31(25.8)

The Area and age of fast food shops

As mentioned above, the designed checklist was used to check the area and the age of the fast food shops. The results were reported in Table 3. Based on this experiment, 51.7% of the examined shops had the age of less than or equal to 5 years. In addition, the area of food preparation in these shops was observed and is as follows: less than 25 m^2 (51.7% of the studied shops), between 25 and 50 m^2 (41.7% of studied shops) and more than 50 m^2 (6.6% of studied shops).

Table 3: Age and area of the fast food shops and restaurants in the under study area

Variable, Type	Frequency, No. (%)
Age (year)	
≤ 5	62(51.7)
6- 10	27(22.5)
> 10	31(25.8)
Area(m^2)	
< 25	62(51.7)
25- 50	50(41.7)
> 50	8(6.6)

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Environmental health status of fast food shops and restaurants

Environmental health status of fast food shops was evaluated based on the food, drink, cosmetics and health materials regulations considering four personal, food, tools and equipment and building factors; the score ≤ 50, the score between 51-70, and the score > 70 were considered as unfavorable level, average level, and desirable level, respectively. The results demonstrated that out of 120 centers, 12.5%, 5%, 11.7% and 5% of the shops had poor condition in different sections of personal, food, tools and equipment, and building hygiene, respectively (Figure 2). As well, 32.5% of the shops had a healthy condition and 67.5% were in the improving phase and on average, they gained the highest score from the building health index.

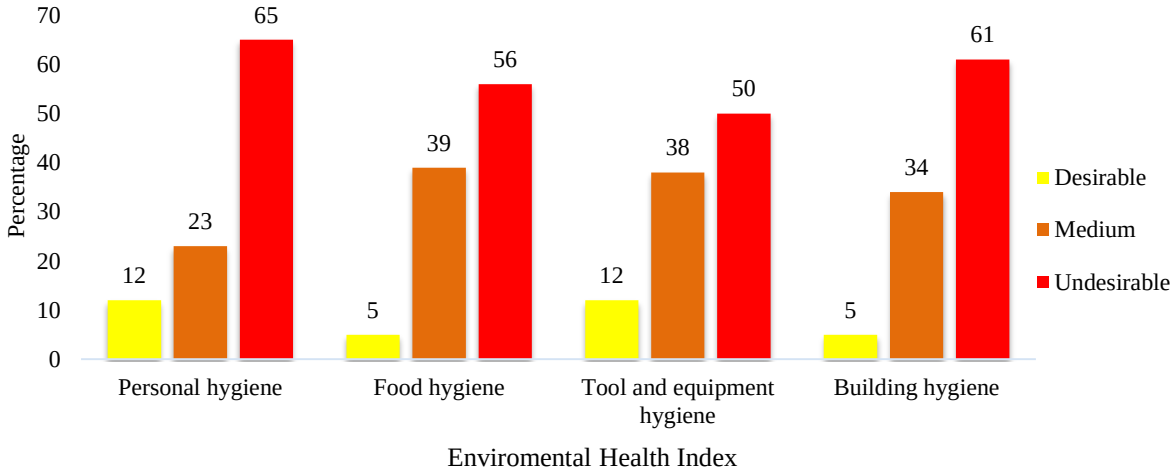

Figure 2: Environmental health status of fast food shops and restaurants

Quality of oil used for cooking in fast food shops and restaurants

Type and the composition of used oil

As it can be seen in Figure 3 and 4, 98% of shops used frying oils, and 46% of the main ingredient composition of used oils was palm. Examination of the type of oil consumed on the basis of the fast food provided also showed that most types of oils consumed in the fast food for preparation of hot dog, Falafel and hamburger is palm oil; soybean oil is also used for frying the potatoes, and there is a consistent distribution of used oils in centers of cocktail baking.

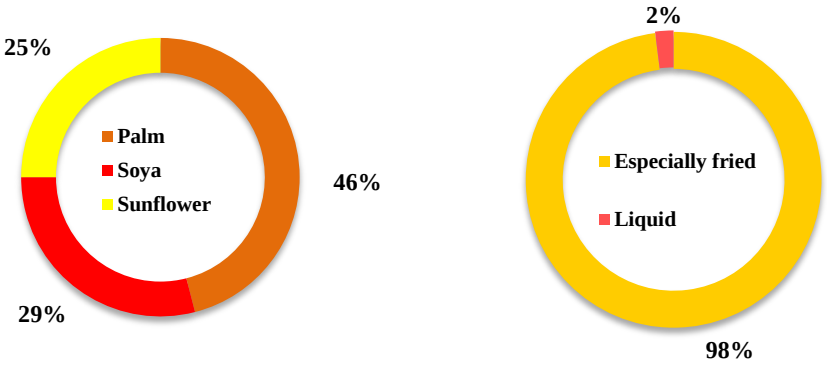

Figure 3: Type and composition of used oils in fast food shops and restaurants

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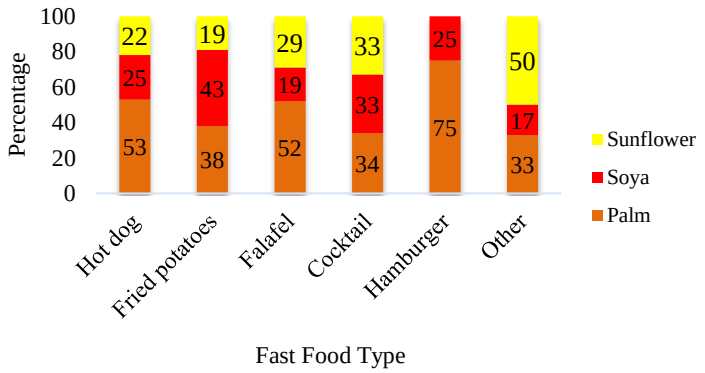

Figure 4: The type of used oil in fast food shops and restaurants according to the type of fast food offered

Time and frequency of using oil

Table 4 demonstrates the duration and frequency of the used oil in the fast food shops and restaurants. Accordingly, the duration of using oil in more than 90% of cases was less than 5 days, but in more than 40% of shops; changing the oil was occurred after being used for more than 20 clients.

Table 4: Duration and frequency of the used oil in the fast food shops and restaurants

Variable, Type	Frequency, No. (%)
Duration of use (day)	
< 1	54(45)
1- 5	56(46.7)
6- 10	9(7.5)
11- 15	1(0.8)
Frequency of using oil per customer	
≥ 20	69(57.5)
21- 60	38(31.7)
61- 100	8(6.7)
101- 140	5(4.2)

Temperature measurement in used oils

Temperature is one of the important parameters in the quality of oil used in food processing[39]. Temperature measurement in oils used revealed that the temperature of the oils used was in the range of 40- 190°C; so that, in 117 shops (97.5%), the temperature of used oil was in the range of 40-160°C; in 2 cases, it was in range of 160-180°C; and in one shop, it was higher than 180°C.

Measurement of oil TMP

TMP of oil was measured to check the quality of oil used (Figure 5). Results demonstrated that, in terms of TMP, 71 samples (59.2%) were at a desirable level, and 49 samples (40.8%) were at an undesirable level and in discard point states.

Statistical analysis showed a significant relationship between temperature, oil use duration, and TPM (P = 0.025). In addition, the shops which had better health status were at a desirable level in terms of oil quality and TPM value (P = 0.048). However, there was no relationship between TPM index and the type of oil used (palm, soybean, sunflower), health and sanitation status and demographic data. A significant relationship was observed between the TPM index and geographical location of the oils (P = 0.00), and district 7 of the municipality of Mashhad with the average TPM of 34.03 ± 7.98 had the highest amount of TPM in used oils.

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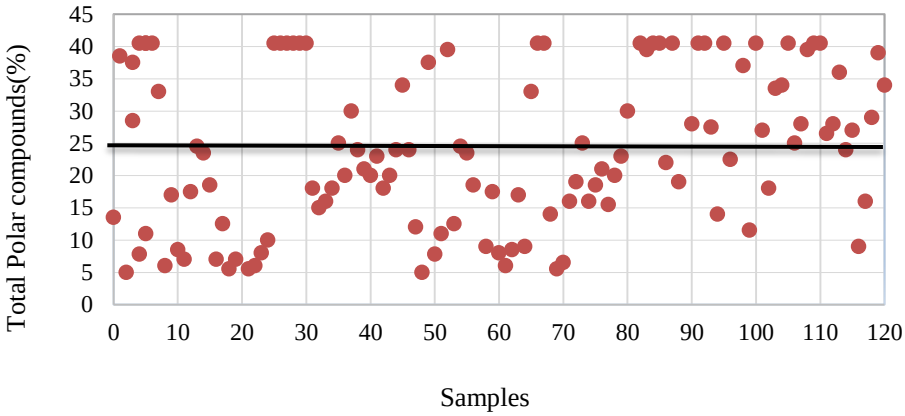

Figure 5: TPM values of used oil in fast food preparation and distribution centers

Measurement of FFA

Another indicator that indicates the oil quality is FFA. As it can be seen in figure 6; the FFA in the samples was in the range of 0–5. FFA index for 45 samples (37.5%) was in a desirable condition, it was in an undesirable condition for 51 samples (42.5%), and it was higher than 5 for 24 samples (20%). Statistical analysis showed a significant relationship between oil use duration and FFA (P = 0.014), but this relationship was not significant between temperature, type of oil used (palm, soybean, sunflower), frequency of oil use, sanitation status and demographic information. Statistical analysis of the geographical location of the shops and FFA index showed that, those shops located in the district 5 of the municipality of Mahshad had the highest values in terms of FFA (mean FFA of 4.23 ± 0.99) (P = 0.00).

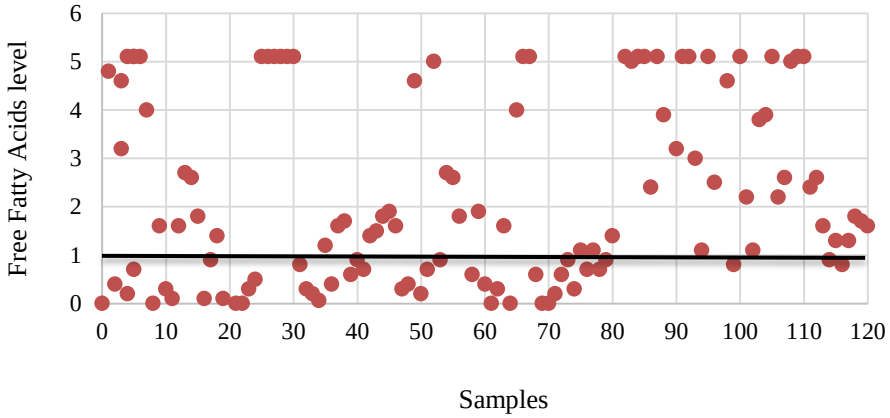

Figure 6: FFA values of used oil in fast food preparation and distribution centers

Discussion

In the present study, the environmental health status of fast food shops and restaurants was evaluated on the basis of four factors, i.e.; personal health, food, tools and equipment, and buildings. The results showed that 12.5%, 5%, 11.7% and 5% of the shops have an undesirable condition, respectively. On average, the highest possible score of the shops was related to the building health index. Although these values seem to be insignificant; employing more specialized staff is needed for more coherent control and oversight due to the annual increase in the number of tourists and pilgrims in the region, the increasing demand, and the importance of providing appropriate services. Increasing the number and reducing the interval between visits and further monitoring can be among effective parameters in improving current conditions.

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Another important consideration is the features and age of the restaurants and shops in the study area and the age of the shops. Restaurants that are fewer than 5 years old and are newly established were in the desirable condition in terms of health status due to upgrading and improving the level of health services offered to attract customers. This clearly demonstrates the importance of renovating and updating the building restaurants and shops. These results are also confirmed by the study conducted by Zangi Abadi et al. on the environmental health assessment of restaurants and hotels in Isfahan[40]. In addition, only 32.5% of the shops were in a good health condition, and 67.5% were only in a sanitation condition. It should be noted that, over time and by increasing the implementing and maintaining costs, more shops will be involved in the problems, and these problems will become more serious and endanger the health of staff and consumers due to the lack of economic justification for managers and owners of the shops[41].

In the studies conducted to survey the demographic information and the quality of used oils, statistical analysis showed that there is no significant relationship between oil quality and the educational level, work experience and obtaining health licenses. However, factors earning the lowest score in the field of personal and equipment hygiene (the most important in providing healthy food), low education (diploma degree and lower) of 80% of employees, and participation of less than 50% of the shops in obtaining a health certificate indicate the need for paying more attention to education[26, 27]. Vahidi et al. showed that holding monthly training courses for operators could change their attitudes, increase the level of hygiene, and ultimately maintain consumers' health[42].

Studying the quality of oil used for cooking in fast food shops showed that 45.8% of the oil constituents were belonged to palm, 29.2% to soybean and 25% to sunflower oil. In a study done by Chen et al., it was found that the average amount of fatty acid in the liquid component of palm oil was 0.071 mg KOH/g which was higher than its component in soybean oil (0.03 mg KOH/g). Normally, the amount of diglyceride in palm oil and soybean oil is 6–8% and 2–3%, respectively[43]. Studies have shown that among the vegetable oils used in deep frying of potato, palm oil increases polar compounds slightly less than sunflower oil[44]. In fact, the peroxide value in palm oils is increased at a slower rate. The presence of palm oil with a relative increase in the amount of saturated fatty acids can improve the desired physical properties of the oil (such as smoke point, low foaming, and viscosity). Considering the low content of fatty acids in palm oils, it has higher resistance compared to other oils[45].

In the present study, the temperature of the oils used in 117 shops (97.5%) was in the temperature range of 40- 160°C; it was in a range from 180 to 160°C in two cases, and it was above 180°C in only one case. The best temperature range for frying the food is 160-180°C because the quality of oil and fat is deteriorated faster at higher temperatures and, the more oil and fat are absorbed by the foods at a lower temperature. Furthermore, increasing the frying temperature from 180 to 215°C significantly increases the rate of thermal degradation and oxidation[46]. During the frying process, the oil is hydrolyzed in the form of free fatty acid and mono and diglycerides. An increase in these volatile compounds can be attributed to an increase in the content of free fatty acid and polar compounds in the oil[47]. A study conducted on frying oil used in the preparation of fast food in an American restaurant showed that fatty acid contents of oil samples increase by increasing the time and temperature which is consistent with the findings of the present study (P = 0.025). Moreover, frying at high temperature leads to increasing the production of carcinogenic and teratogenic compounds and to create some problems in fat and glucose metabolism and liver function[48-50] which not only can threaten consumers of fried foods, but also it can affect employees' health through absorbing vapors and volatile compounds[51].

In terms of the frequency of the oil use, the results showed that, in 43% of cases, the oil

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change was performed for every 20 customers which are not good given the high number of clients. A study conducted in Kuala Lumpur, Malaysia, on cooking oils showed that 67% of operators did not agree to reuse the oil, and 69% believed that reuse of oils is detrimental to health. However, 63% of operators admitted that they have been using used oil frequently[52]. Certainly, the frequency of use in this study was not quantified. Although the relationship between the oil quality indices and the frequency of the oil use was not significant in the present study; the consumption of foods fried by the oils that have been repeatedly consumed is undesirable from the health point of view and may increase cardiovascular diseases[12].

As mentioned before, in terms of the TPM index, 71 samples (59.2%) were desirable, and 49 samples (40.8%) were undesirable and in a poor condition. Moreover, in terms of FFA, 45 samples (37.5%) had a favorable condition, and 75 samples (62.5%) had an unfavorable condition. Given the meaningful relationship between the oil usage duration and the measured indices; these adverse values may indicate the lack of regular changing of the oil and overuse of the oil which is consistent with findings of the study carried out by Totani et al.[53]. Other factors that contribute to the creation and acceleration of *spicy tastes* of the oil can be heat, degree of unsaturation, light, contamination of oil with spicy fatty substances, and contamination with metal and air[54]. Accordingly, the creation of vacuum frying, regular oil changing and the use of natural antioxidants (vitamin E is most important of them) can be considered as beneficial measures in maintaining the quality of the edible oil[43]. Surely, Ramadan et al. have addressed another aspect and argued that increasing the amount of free fatty acid is not an ideal reliable parameter for the assumption of decomposing the frying oil because it is difficult to distinguish between fatty acid generated by oxidation and fatty acid generated by hydrolysis[55]. In addition, the low molecular weight of free fatty acid may be lost by volatilization during the frying process[17].

Conclusion

The results of this study showed that about half of the frying oils used in the preparation of fast foods were undesirable. In addition, considering that the oil quality is affected by factors such as temperature, usage time of the oil and its relationship with different areas of environmental health according to food, drink, cosmetics and health materials low; paying attention to the importance of renovation of buildings, training the employers and staff, continuous provision, monitoring and implementing strict legal measures to deal with offenders can be considered as the most important corrective measures. Besides, lack of awareness among staff and managers of the restaurants and fast food centers about the deleterious effects of frying oil and lack of timely detection of the oil changing time are of the main causes of corruption and lower quality of edible oils which ultimately can endanger the consumers' health.

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Conflict of interest

The authors confirm that there is no conflict of interest regarding the publication of this article.

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